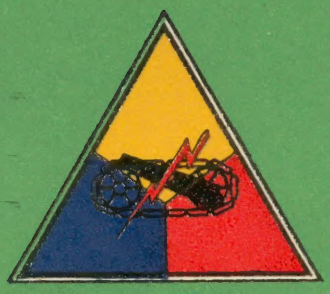

ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

PROJECT NO. 3 - TOXIC GASES IN ARMORED VEHICLES

Partial Report On

Sub-Project No. 3-9 - Determination of the Ventilation Requirements for Gas-Proofing Tanks

VENTILATION REQUIREMENTS FOR GAS-PROOFING THE M-5 TANK

Project No. 3-9

24 December 1942

ARMORED FORCE MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

December 24, 1942

Project No. 3-9
File No. 724.2

PARTIAL REPORT ON VENTILATION REQUIREMENTS FOR GAS-PROOFING THE M-5 TANK

1. PROJECT: Determination of the Ventilation Requirements for Gas-Proofing Tanks.

a. Authority - Letter Commanding General, Headquarters Armored Force, Fort Knox, Kentucky, 400.112/6 GNOHD, dated September 24, 1942.

b. Purpose - To determine the capacity of a pressure ventilating system and gas canister required to maintain adequate positive-pressure within the M-5 tank.

2. DISCUSSION:

a. Methods: The fighting compartment of an M-5 tank was sealed as completely as possible and air delivered into it at measured rates from an external fan, the corresponding static pressures within the fighting compartment being noted. Following this, various leakage areas were successively unsealed and new pressure-volume curves obtained. The difference between any two successive curves represented the rate of leakage contributed by the particular area which was opened up. Pressure-volume curves obtained in this manner are shown, for the important sources of leakage, in the Appendix.

3. CONCLUSIONS:

a. The M-5 tank of standard construction has too much leakage to permit the use of positive-pressure ventilation for protection against outside contamination.

b. Major leakage areas are the turret ring and the mounting of the 37 mm gun which contribute 208 and 780 cubic feet per minute, respectively, at ½" water pressure.

c. Other points of leakage, such as the hatches, periscopes, etc. contribute relatively small quantities of flow and are simple to correct to a minimum rate of leakage.

d. With the turret ring and the 37 mm gun mounting corrected by means of gaskets, reduced clearances, or other means, it is believed that the M-5 tank can be equipped with a system of positive-pressure ventilation for gas-proofing.

4. RECOMMENDATIONS:

a. That Ordnance Department be requested to prepare an M-5 tank with a tight bulkhead and with minimum leakage around turret ring and 37 mm gun mount, this tank to be shipped to Fort Knox for further tests by the Armored Force Medical Research Laboratory.

b. If the leakage is found to be reduced sufficiently, a positive-pressure system of ventilation and gas canister will then be installed for actual field tests.

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APPENDIX

Gas-proofing of the M-5 tank requires that the ventilation of the tank be provided by a pressure system so as to maintain an outward flow of air through cracks and other leakage openings. The capacity of the pressure ventilating system is necessarily limited by the space requirements for the installation of the fan, motor, gas canister and other appurtenances. It must, however, be adequate to maintain the required pressure within the tank, and, for a given pressure, the capacity will be determined by the total area of the leakage openings in the hull. In order to determine the magnitude of the system capacity, air was delivered into the buttoned-up tank through an orifice meter and the static pressure within the tank determined for different rates of air flow. A pressure-volume curve was first obtained with the tank sealed as tightly as possible. Following this, specific leakage areas were unsealed and new pressure-volume curves obtained. Thus, the difference in the air flow values at a given pressure for two adjacent curves gave the rate of leakage (at a given pressure) for the opening which had been unsealed. Owing to the fact that the work was done on a standard tank it was not possible to seal the bulkhead completely and as a consequence, an unknown quantity of air was leaking constantly through it. Also, it was not possible, by the means at hand, to seal the turret ring completely. For these reasons, the pressure-volume relationship for the turret ring presented herewith represents minimum values. The other relationships, however, are substantially correct since they were obtained by difference with the unknown leakage constant.

The pressure-volume curves for certain important leakage points are shown in Fig. 1 and from these the following values are taken.

Leakage Area	Rate of Air Flow At	
	½" Static	1" Static
1. Turret Ring (Minimum)	208 cfm	323 cfm
2. 37 MM Gun Mount	780 cfm	1180 cfm
3. Turret Hatch Assembly (Est.)	51 cfm	75 cfm
4. Bow Hatches	24 cfm	34 cfm
5. One Periscope	17 cfm	24 cfm

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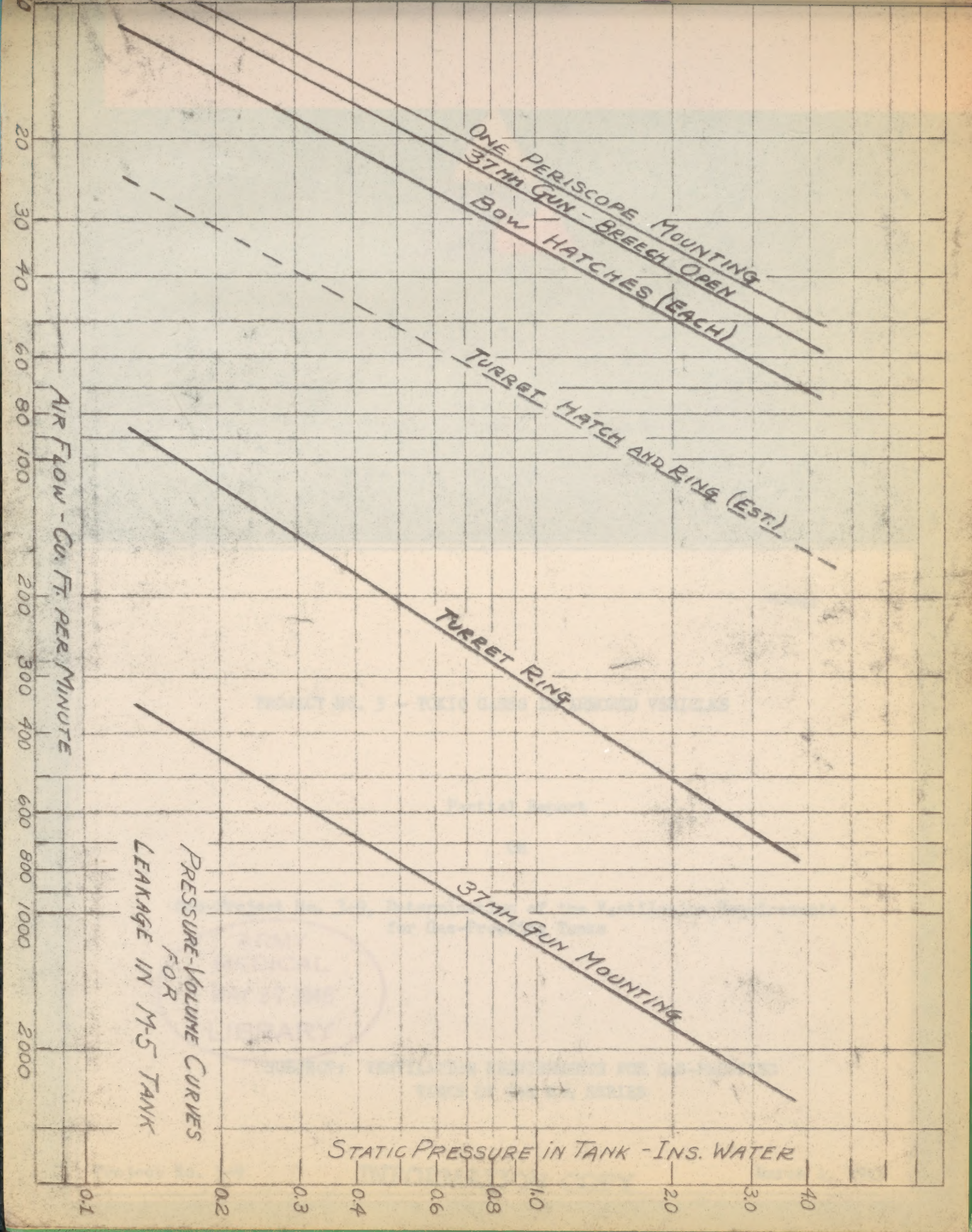
Until actual tests have been conducted under representative field conditions, the internal pressure required to prevent the entrance of toxic gases released outside the tank cannot be definitely determined. Assuming a static pressure of ½" water, however (which will produce an outward velocity of approximately 2000 fpm, or 23 miles per hour) one notes that the leakage values for the turret ring and 37 mm gun mount are 208 and 780 cfm respectively. In comparison, the other values are of little significance and, furthermore, can be reduced to still lower values by relatively simple means of gasketing. As now constructed, however, the turret ring and 37 mm gun mount are not readily sealed and the quantities of air which will escape at a pressure of ½" water are so great as to make it impractical to provide the positive-pressure ventilation required. This is true not only with respect to the space and power requirements of the fan but also with respect to the space occupied by the gas canister.

It does not follow from the foregoing that gas-proofing of the M-5 tank is impossible since the leakage can be greatly reduced by certain changes in construction. It is therefore proposed that an M-5 tank be prepared for further tests, specifically to provide:

1. A tight bulkhead.
2. Suitable gasket or other sealing around turret ring.
3. A practical seal around the 37 mm gun mount.



PRESSURE-VOLUME CURVES FOR LEAKAGE IN M-5 TANK